Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

Wireless Telecommunications Bureau and Office of Engineering and Technology Seek Comment on NextNav Petition for Rulemaking	))))	WT Docket No. 24-240

COMMENTS OF THE LORA ALLIANCE

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Executive Summary

NextNav's Petition for Rulemaking seeks unprecedented access to prime, additional spectrum holdings at the expense of the successful operations of billions of unlicensed devices in the 902-928 MHz band. The Commission should not move forward with a rulemaking that would consider such a proposal.

The LoRa Alliance® ("Alliance"), like many other Part 15 technology groups, is gravely concerned about the impact of NextNav's proposal on its installed base and future applications. The Alliance provides a technical analysis demonstrating the direct and reverberating impacts of the NextNav proposal on LoRaWAN operations. In sum, NextNav's request would limit LoRaWAN operations to 60% of the available band, cause unacceptable levels of interference to many LoRaWAN systems and operations, and limit the amount of competition in the United States for Internet of Things ("IoT") technologies.

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NextNav proposes a wholesale change to the Part 90 Multilateration Location and Monitoring Service ("M-LMS") rules, enabling it to essentially trade highly service restrictive licenses for a flexible nationwide license to provide any type of mobile or fixed service.[1] The proposal would offer minimal benefit to anyone other than NextNav, while disrupting services to billions of devices and millions of end users. The Federal Communications Commission ("FCC" or "Commission") should not proceed with a rulemaking to consider NextNav's proposal.

I. BACKGROUND

A. Introduction

The LoRa Alliance® ("Alliance") is an open, nonprofit association that has become one of the largest and fastest-growing alliances in the technology sector since its inception in 2015. Its vision is to empower sustainable Internet of Things ("IoT") connectivity to maximize efficiency, improve quality of life and protect the planet's resources, and to achieve massive IoT through the global adoption of LoRaWAN® technology.

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[1] *Enabling Next-Generation Terrestrial Positioning, Navigation, and Timing and 5G: A Plan for the Lower 900 MHz Band (902-928 MHz)*, Petition for Rulemaking of NextNav Inc., RM-11989 (filed April 16, 2024) ("NextNav Petition").

Alliance members closely collaborate and share experiences to promote and drive the success of the LoRaWAN standard as the leading open global standard for secure, carrier-grade IoT LPWAN connectivity.

With the technical flexibility to address a broad range of IoT applications, both static and mobile, and a certification program to guarantee interoperability, LoRaWAN has already been deployed by major network operators globally, with wide expansion continuing into 2024 and beyond. In fact, LoRaWAN is expected to have a global CAGR of 17.6% by 2027, with nearly 150 million chipsets shipping that year, according to Beecham Research.

LoRa Alliance members come from organizations of all types around the world and address all aspects of the ecosystem. Members include multi-national telecommunications companies, equipment manufacturers, system integrators, sensor manufacturers, entrepreneurial start-ups, and semiconductor companies. In the United States, our members develop, deploy and use the technology driving the implementation of the Internet of Things.

In terms of LoRa Alliance membership, approximately one third of our organizational members are based in the U.S. (~400 active individual members based in US supporting development, certification and marketing of the LoRaWAN standard). U.S. companies also account for more than half of the LoRa Alliance's Board of Directors.[2]

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[2] *See* https://lora-alliance.org/board-officers/

B. Demand for LoRaWAN Technology

LoRaWAN technology has firmly established itself as a cornerstone of the IoT revolution across the United States, with tens of millions of sensors deployed in thousands of cities and throughout rural areas, catering to a diverse array of use cases. The flexibility of LoRaWAN networks allows them to be integrated into both densely populated urban environments and remote, rural regions, serving critical commercial and non-commercial applications alike. From the skyscrapers of New York City to the farmlands of Kansas, LoRaWAN networks are driving advancements in smart cities, agriculture, healthcare, public safety, environmental monitoring, and industrial operations, among the many uses.

In urban centres like Los Angeles, San Francisco, and Pittsburgh, LoRaWAN supports essential smart city initiatives that include smart water metering, environmental monitoring, and traffic management. Los Angeles, for instance, has deployed 1,460 smart parking sensors supported by approximately 50 gateways, enhancing urban mobility and reducing traffic congestion. In San Francisco, around 5,000 smart water meters and 500 environmental sensors are bolstered by 40 gateways, contributing to efficient water management and public safety. Pittsburgh International Airport exemplifies how LoRaWAN improves operational efficiency through the deployment of over 2,000 devices supported by 30 gateways, facilitating asset tracking and environmental monitoring.

The impact of LoRaWAN extends far beyond urban landscapes. In rural areas, its applications are transforming industries such as agriculture and environmental conservation. In Independence, KS, over 1,000 soil moisture sensors and agricultural devices, supported by 15 gateways, enable precision farming and resource management. Similarly, in Alvord, TX, the deployment of 800 cattle tracking sensors, supported by 10 gateways, is revolutionizing ranching operations. The Great Lakes Region benefits from more than 2,000 environmental monitoring devices, supported by 25 gateways, which help track pollution levels and manage critical infrastructure.

Utility companies across the U.S. also heavily rely on LoRaWAN for smart metering solutions, which is evident from the large-scale deployments in various regions. Miami, FL has installed half a million smart water meters, while Newport News, VA, and Gilbert, AZ have deployed about 130,000 and 100,000 smart water meters, respectively. These deployments are typically supported by dozens of gateways, ensuring reliable and efficient data transmission for utility operations. In smaller towns like Beverly Hills, CA, and Coconut Creek, FL, LoRaWAN networks comprising thousands of sensors (31,326 and 12,220 respectively) are vital in managing water resources and ensuring environmental sustainability.

The non-commercial applications of LoRaWAN are equally significant, with deployments in public safety, healthcare, and education. The U.S. Army has adopted LoRaWAN for advanced communication systems, enhancing public safety operations. East Carolina University in North Carolina is leading a smart campus initiative using more than 2,500 devices, supported by 30+ gateways, for environmental monitoring and energy management. In the healthcare sector, LoRaWAN supports remote patient monitoring and asset tracking in hospitals, ensuring better patient care and efficient use of resources.

Collectively, these examples illustrate the widespread adoption of LoRaWAN in the U.S., with tens of millions of devices and millions of gateways deployed across the country so far (and, with the expected growth of LoRaWAN in the U.S., hundreds of millions of devices are expected to be deployed by 2029). Annex 1 provides additional examples of the many use cases and locations of use of LoRaWAN in the United States on the 902-928 MHz band.

LoRaWAN devices are supported by an extensive network of gateways, which not only facilitate seamless communication but also ensure the scalability and reliability of LoRaWAN networks. As LoRaWAN continues to expand into 2024 and beyond, it is poised to further revolutionize the IoT landscape, empowering smarter cities, more efficient industries, and more sustainable environmental practices across the United States.

C. LoRaWAN Technological Overview

The LoRa Alliance has defined a channel plan suitable for operation in the U.S. in the 902-928 MHz band. The channel plan is a combination of channels, modulation and data rates, and operational rules that allow inter-operability between end-devices and LoRaWAN networks. End-device certification includes the channel plan. End-device manufacturers need to seek regulatory type approval, even if their device is LoRaWAN certified.

Channels, modulations and data rates are the following:

- Upstream – 64 channels, numbered 0 to 63, utilizing LoRa (chirp spread spectrum) 125 kHz bandwidth, varying from SF10 (1kbps) to SF7 (5.5kbps), starting at 902.3 MHz and incrementing linearly by 200 kHz to 914.9 MHz
- Upstream – 8 channels, numbered 64 to 71, utilizing LoRa 500 kHz bandwidth at SF8 (12.5 kbps) or LR-FHSS 1.523 MHz bandwidth at 162/325 bps, starting at 903.0 MHz and incrementing linearly by 1.6 MHz to 914.2 MHz
- Downstream – 8 channels, numbered 0 to 7, utilizing LoRa 500 kHz bandwidth at SF12 (1 kbps) to SF7 (22 kbps), starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz

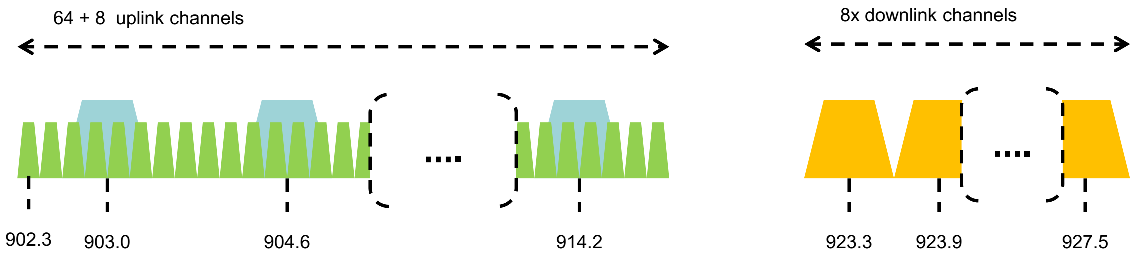

Figure 1: US 902-928 channel frequencies (LR-FHSS channels not represented)

To comply with Part 15 regulatory specifications, LoRaWAN operations use either the FHSS mode (upstream LR-FHSS), Hybrid mode (upstream LoRa 125 kHz with less than 50 channels), or Digital Transmission System (upstream or downstream LoRa 500 kHz). Dwell time and transmission power levels comply with Part 15. An end-device will typically use hybrid mode with +21 dBm, and a gateway will use DTS with +26 dBm. For each data rate, payload length is limited to comply with the 400 ms maximum dwell time.

A gateway typically listens to 8, 16 or 64 channels within the 64 channels numbered 0 to 63, and respectively 1, 2 or 8 channels within the 8 channels numbered 64 to 71. Optionally one of the channels in the 64 to 71 index range can be configured for LR-FHSS. When a gateway supports a channel, it can receive any data rates defined for this channel.

Uplink transmissions happen at arbitrary times, using any of the available channels. The set of available channels, and the used data rate are dynamically controlled by the network for each end-device individually.

Downlink transmissions occur at deterministic times after an uplink with two defined downlink opportunities, which also have deterministic channel and data rate. All eight defined channels are used for downlinks. One optional mode of operation defines a low latency downstream, using a determined downlink channel (per end-device), which the end-device listens to permanently or at regular times. The transmissions from end-devices are not coordinated and are randomized in time to prevent synchronization from external events (*e.g.*, network outage, alarms, power outage). Initial network access uses a sequence that uses all 64+8 upstream channels and that minimizes the number of attempts to reach a gateway that has only 8+1 or 16+2 active upstream channels.

II. DISCUSSION

NextNav has requested that the Commission commence a rulemaking proceeding to determine whether to modify Part 90 of its rules to allow NextNav to convert its M-LMS licenses into larger and much more valuable broadband licenses. This proposal would cause severe disruption to the unlicensed operations in the band while providing a windfall of valuable spectrum holdings to NextNav. Such a result would be in direct conflict to the Commission's obligations under the Communications Act of 1934 to make spectrum resources available for use in the public interest.[3] For this reason, the FCC should not consider the proposed rule changes.

A. The FCC Should Not Proceed with a Rulemaking that Drastically Changes the Operating Environment of the 902-928 MHz Band.

i. NextNav's Proposal Represents a Significant Departure from M-LMS Operations

NextNav has proposed a significant expansion of both the use of spectrum and the geographic area of operations of M-LMS. It now seeks a nationwide license to provide any type of fixed or mobile broadband services under technical rules established for cellular communications.[4] NextNav would operate with power levels up to 2000 W/MHz (3280 W/MHz EIRP), transmitting any type of data for any type of operations, two-ways, and interconnecting with the public switched network.[5]

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[3] *See, e.g.*, 47 U.S.C. §§ 151, 301, 303(g), and 309(a).

NextNav's proposal to repurpose the spectrum for 5G broadband use introduces significant risks of disrupted operations, particularly for IoT services that rely on LoRaWAN. As detailed below, under the proposed rules, NextNav's 5G base stations will disrupt LoRaWAN devices operating within a 5 km radius in urban areas, potentially affecting essential services in thousands of cities across the U.S. The impact to LoRaWAN could be even greater in rural areas due to different signal propagation characteristics.

Thus, this proposed rule change is significantly different from the Commission's 2013 Limited Waiver Order, which was granted because it was designed to reduce the interference potential to unlicensed users.[6] At that time, the Commission determined that Progeny could make minor changes to the use of its M-LMS licenses because "[t]his limited waiver did not create or establish a new service" but instead "effectively lowered the potential for interference from Progeny's operations in the band."[7] Here, however, NextNav's proposal will be wildly disruptive to many operations in a heavily used unlicensed band.

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[4] *See* Letter to Marlene H. Dortch, Secretary, FCC from Robert Lantz, General Counsel, NextNav Inc., Re Rule supplement to NextNav Inc. petition for rulemaking, WT Docket No. 24-240 (June 7, 2024) ("NextNav Supplement").

[5] *Id.*

[6] *Request by Progeny LMS for Waiver of Certain Multilateration Location and Monitoring Service Rules; Progeny LMS, LCC Demonstration of Compliance with Section 90.353(d) of the Commission's Rules*, Order, WT Docket No. 11-49 (rel. June 6, 2013) ("Progeny Order").

[7] *Id.* at ¶ 13.

Moreover, NextNav also seeks to eliminate Section 90.353(d), which provides that M-LMS licenses engage in joint testing with unlicensed users to assure that their commercial operations will not cause "unacceptable levels of interference" to unlicensed devices.[8] This rule was adopted as part of an overall framework designed to promote the successful coexistence between the already-established unlicensed users and the newly created M-LMS service.[9] As the FCC explained, its goals were to "facilitate band sharing and minimize interference to Part 15 operations, and that as part of that effort it sought to ensure that LMS systems are not operated in such a manner as to degrade, obstruct, or interrupt Part 15 devices to such an extent that Part 15 operations will be negatively affected." FCC sought to "achieve the most efficient coexistence possible" and "ensure that M-LMS licensees, when designing and constructing their systems, take into consideration a goal of minimizing interference to existing deployments or systems of Part 15 devices."[10] The Alliance believes that the rules created to promote co-existence between M-LMS and Part 15 users continue to be fundamental to the successful operations of Part 15 systems, and does not support elimination of the rule.

ii. The FCC Should Not Favor One Licensee at the Expense of Billions of Devices

Contrary to NextNav's assertion that this band is underutilized, the 902-928 MHz band has a vibrant ecosystem of Part 15 users. As the current record and past 902-928 MHz proceedings demonstrate, there are presently billions of unlicensed devices operating in the band. While the FCC rules require that unlicensed users accept harmful interference from authorized users, as explained above the Commission designed the rules for LMS to provide a balanced playing field between M-LMS and Part 15 operations. NextNav's proposal throws this co-existence regime on its head, suggesting rules that would create a nationwide, high-powered 5G service never before in operation in the band. Other Part 15 users appear to agree. Hundreds of filings in the record to date oppose NextNav's proposal. For example, the RAIN Alliance, Consumer Technology Association, and the Z-WAVE Alliance agree that NextNav's proposal will cause significant disruptions to the services of millions of unlicensed devices.

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[8] 47 C.F.R. § 90.353(d).

[9] *See id*. at ¶ ¶ 9-10.

[10] *Id*. at ¶ 11.

The FCC seeks comment on the costs and benefits of NextNav's proposal to reconfigure the 902-928 MHz band. Given the incredibly broad extent of Part 15 operations in the band, supporting many critical public services such as school panic buttons, infrastructure and assets tracking, environmental hazards detection, etc., any rule change that causes a severe impediment to these operations must provide at least an equal public benefit. Yet in this instance, there are serious questions about the benefit of NextNav's proposed Terrestrial Positioning, Navigation, and Timing Service ("TPNT"). There seem to be other providers of similar services (such as the eight other entities that received Department of Transportation grants) and other cellular operators using 3GPP technology in neighboring 900 MHz bands. NextNav offers no legitimate public interest justification for such a drastic reconfiguring of the M-LMS rules. There certainly is no indication that any benefit that NextNav claims to offer will offset what would be lost by the severe diminishment of LoRaWAN and other Part 15 operations.

B. NextNav's Proposal Will Significantly Harm LoRaWAN Operations in 902-928 MHz.

i. Technical Analysis Shows that NextNav's Proposal Will Cause Significant Service Disruptions to LoRaWAN Systems

The Alliance has prepared a Technical Analysis, attached to this filing in Annex 2. This coexistence study demonstrates that NextNav and LoRaWAN systems would not be able to share the same portion of the 902-928 MHz band when operating within 5 km radius around a NextNav base station. Significantly, each new NextNav gateway, operating under the proposed conditions, would likely cause unacceptable levels of interference with LoRaWAN devices within a 5 km radius, disrupting essential services. This impact could be even more pronounced in rural areas due to the unique propagation characteristics of these environments.

Based on technical calculations, the proposed NextNav Base Stations, with an Effective Radiated Power (ERP) of 1000 W/MHz (and up to 2000 W/MHz in rural areas), would not be compatible with LoRaWAN networks due to the required attenuation of the NextNav signals necessary to avoid unacceptable levels of interference to LoRaWAN devices. These operations pose a serious threat to the reliable operation of LoRaWAN networks across the country.

Should the FCC approve NextNav's proposed regulatory changes, tens of millions of LoRaWAN devices operating in the 902-928 MHz band could become inoperable, halting thousands of commercial and non-commercial applications nationwide. Without a detailed plan from NextNav on how it will prevent unacceptable levels of interference to LoRaWAN and other Part 15 devices, the 902-928 MHz band could become unusable for existing critical services.

LoRaWAN users could lose use of much more than half of the available 902-928 MHz band:

- The proposed rules would require the LoRa Alliance to define a new channel plan that fits the reduced available spectrum for Part 15 devices in the U.S., along with the corresponding certification program. This would require device makers to modify existing devices and build new devices that comply with this new channel plan, get LoRaWAN certification that ensures interoperability, and seek regulatory-type approval. This effort would require a massive overhaul in an ecosystem and industry, one firmly established on a hugely successful, long-used unlicensed band.
- The transition of existing LoRaWAN networks to a new channel plan would require a duplication of gateways, since each gateway may only be configured for a single channel plan.
- A new channel plan created to avoid unacceptable levels of interference from NextNav would not allow full duplex operation, which is possible today. Full duplex operation effectively increases network capacity, whereas half duplex operations require the use of additional gateways to reach the same capacity. Also, not having full duplex capabilities lowers the quality of service as half duplex gateways miss uplink transmissions while they transmit on the downlink, because uplinks occur at non-coordinated times.

Moreover, if NextNav were to operate under its proposed rules, the coexistence between LoRaWAN and other Part 15 users also would be disrupted. Thus, the FCC must consider not only the impact of NextNav's proposed service on Part 15 operations, but also whether Part 15 users will be able to successfully coexist with each other in the remaining portion of the band under the current Part 15 rules and continue to offer services already deployed today (let alone in the future). While LoRaWAN has adopted a flexible channel plan approach where channels are dynamically allocated to avoid other systems (*e.g.*, RFID), if the available spectrum is reduced by almost half, this will be much harder to achieve because of the concentration of all systems in the remaining portion of the band. Overall, the inability to coexist on the same portion of the band will reduce the quality and reliability of all systems already sharing the 902-928 MHz band. Eventually, NextNav's operations would reduce competition for IoT services, as if LoRaWAN capabilities are hindered then IoT system deployment might be limited to cellular technologies.

The Alliance acknowledges NextNav's offer to work with Part 15 users and is willing to engage in discussions. However, given the extreme change in the 902-928 MHz band that NextNav seeks, which will significantly alter the operating environment, an agreeable solution will be difficult without major changes to the proposed rules. Whatever solution or mitigation technique found, if any, between NextNav's new system and one Part 15 technology may not apply to other Part 15 technologies. And a solution for one Part 15 technology must be considered in light of the solutions found for other Part 15 technologies to assess the possible collateral effects on the entire Part 15 installed base.

C. The Proposed Rules from NextNav are Contrary to the Public Interest

NextNav's proposal amounts to a spectrum swap – in this instance, one in which a single licensee receives more spectrum than it currently holds. This would be unprecedented. The Commission generally authorizes spectrum swaps in instances where incumbents are moved to free bandwidth for new uses[11] or resolve interference[12] or for spectrum efficiency.[13] In all instances, the decision clearly served the public interest, convenience, and necessity, as required by the Communications Act.[14] As discussed above, however, NextNav's proposal has not demonstrated public interest benefit.

Moreover, this is a licensee that has essentially failed for twenty-four years to put its spectrum holdings into any type of useful service. This violates FCC prohibitions against spectrum warehousing[15] and violates the Commission's duty under the Communications Act to ensure that the radio spectrum is put to use in the public interest.[16]

The Commission should not consider a change to its rules that benefits – and actually provides a great windfall to – one licensee while drastically limiting the valuable use of a band by millions of other users.

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[11] *See Improving Public Safety Communications in the 800 MHz Band*, Report and Order, 19 FCC Rcd 14969 (2004).

[12] *See Establishing Rules and Policies for the Use of Spectrum for Mobile Satellite Services in the Upper and Lower L-Band*, Report and Order, 17 FCC Rcd 2704 (2002)

[13] Letter to Michele Farquhar, Hogan Lovells (US) LLP from Roger Noel, Chief, Mobility Division, Wireless Telecommunications Bureau, FCC, 30 FCC Rcd 4635 (2015) (allowing spectrum swap for railroad positive train control services when spectrum efficiency and the public interest would be served).

[14] 47 U.S.C. § 316.

[15] *See e.g.*, *Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, & 101 et al.*, Second Report and Order and Further Notice of Rulemaking, 32 FCC Rcd 8874 (2017) (adopting multiple rule changes to prevent spectrum warehousing).

[16] 47 U.S.C. § 303.

III. CONCLUSION

For the foregoing reasons, the Commission should not commence a rulemaking to modify the M-LMS rules pursuant to NextNav's request.

Respectfully submitted,

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ANNEX 1

LoRaWAN networks across the U.S. support diverse applications in various sectors, including:

- Energy and Utilities
    - Smart metering (electric, gas, water)[17]
    - Grid management and optimization
    - Renewable energy monitoring (solar, wind)
    - Energy consumption reduction
- Building
    - Building automation (HVAC, lighting control)
    - Environmental monitoring (temperature, humidity, gas leaks, air quality)
    - Security and access control systems
    - Predictive maintenance and asset management
    - Refrigeration, presence, facilities management, trash bin monitoring
    - Water and gas leak prevention
- City
    - Street lighting and smart parking
    - Waste management
    - Waste water and flood control
    - Air quality and noise monitoring
    - Traffic management and congestion reduction
    - Asset and fleet tracking
- Agriculture
    - Soil moisture and nutrient monitoring
    - Weather station data collection
    - Livestock tracking and health monitoring
    - Irrigation control systems
    - Propane tank delivery and refills
    - Fire control monitoring
    - Silo and storage monitoring
- Environmental Monitoring
    - Water quality and flood monitoring
    - Wildlife tracking and habitat monitoring
    - Pollution and emissions monitoring
    - Forest and wildfire detection systems
    - Flood control

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[17] Utilities like Mueller, Neptune: Potential significant impacts, especially for water meters.

- Industry and Manufacturing
    - Supply chain and logistics monitoring
    - Equipment tracking and management
    - Predictive maintenance in manufacturing
    - Remote monitoring of industrial sites (oil and chemical processing)
    - Pipeline monitoring
    - Work safety
    - Leak detection
- Public Safety
    - Emergency response and disaster management
    - Infrastructure monitoring and asset tracking
    - Environmental hazards detection
    - Critical infrastructure protection
    - Panic buttons in Schools and Universities
    - Food safety and FDA support
- Healthcare
    - Remote patient monitoring
    - Asset tracking in healthcare facilities
    - Smart drug delivery systems
    - Environmental monitoring in hospitals
    - Temperature monitoring of medication
- Transportation and Logistics
    - Fleet management and telematics
    - Cold chain monitoring
    - Asset tracking and inventory management
    - Traffic flow optimization
    - Shipping and construction laydown yards
    - Construction asset monitoring including concrete curing
- Retail
    - Inventory tracking and management
    - Customer behavior analytics
    - Energy management in retail spaces
    - Automated shelf and product monitoring
    - Food safety and grease trap maintenance
    - Indoor air quality and climate control (HVAC & BMS)
    - Predictive Cleaning

The following is a non-exhausted list of examples of critical commercial and non-commercial LoRaWAN deployments across the U.S., highlighting the range of applications, scale of implementation, and widespread reliance on 902-928 MHz:

- Alvord, TX
    - Cattle tracking solutions for ranching operations using LoRaWAN sensors.
    - 800+ cattle tracking sensors, supported by 10 gateways.

  - 570 Accounts
- Arlington, VA
  - Smart parking and traffic management with 4,200 sensors deployed across the city.
  - 4,200 smart parking sensors, supported by 35 gateways.
- Ashtabula OH
  - 5,689 sensors
- Austin, TX
  - Smart city infrastructure projects, including environmental monitoring and IoT research at the University of Texas.
  - 4,000+ devices deployed across various applications, supported by 60+ gateways.
- Bay County, MI
  - Environmental monitoring, water quality assessments, and public health safety measures.
  - 1,500+ environmental and water quality sensors, supported by 20 gateways.
- Beverly Hills
  - 31,326 sensors
- Branson MO
  - 4,622 sensors
- Brunswick-Glynn County, GA
  - Water metering solutions
- Chesapeake, VA
  - Water metering solutions
- City of Rialto CA
  - Water metering by Veolia Water
  - 12,292 sensors
- Coconut Creek FL
  - 12,220 sensors
- Dania Beach FL
  - 5,012 sensors
  - 52,476 sensors
- Deltona, FL
  - Water metering solutions
- East Carolina University, NC
  - Smart campus initiative for environmental monitoring and energy management.
  - 2,500+ devices across campus, supported by 30+ gateways.
- Fairhaven, MA
  - Water metering solutions
- Gilbert, AZ
  - Smart water metering
  - About 100,000 smart water meters with approximately 35 gateways
- Great Lakes Region
  - Environmental monitoring and infrastructure management, including water level sensors and pollution tracking.
  - Over 2,000 environmental monitoring devices, supported by 25 gateways.

- Griffin, GA
    - Water metering solutions
- Huntington Park, CA
    - Parking management and traffic congestion reduction with 1,460 sensors deployed for smart parking.
    - 1,460 parking sensors, supported by 20 gateways.
- Independence, KS
    - Smart agriculture solutions, including soil moisture monitoring and precision farming applications.
    - 1,000+ soil moisture sensors and agricultural devices, supported by 15 gateways.
    - 4,063 sensors already installed & 700+ remaining
- Kannapolis, NC
    - Smart water metering
    - About 20,000 smart water meters with approximately 15 gateways
- Kirkland, WA
    - Real-time smart parking data collection with 500 sensors to optimize parking availability and reduce congestion.
    - 500 parking sensors, supported by 15 gateways.
- Lake Havasu NV
    - 32,960 sensors
- Lander WY
    - 7,581 sensors
- Los Angeles, CA
    - Smart parking infrastructure, environmental monitoring, air quality sensors, and urban mobility improvements.
    - 1,460 smart parking sensors deployed across the city, supported by about 50 gateways.
- Miami Dade
    - 499,000 sensors
- Newport News, VA
    - Smart water metering
    - About 130,000 smart water meters with approximately 35 gateways
- New York City, NY
    - Utility operations (smart water metering), building management, food safety monitoring, smart street lighting, and air quality monitoring.
    - Over 10,000 LoRaWAN devices deployed across the city, supported by approximately 100+ gateways.
- Nuevo, CA
    - Agricultural monitoring, including irrigation control and soil moisture tracking.
    - 700+ irrigation control sensors, supported by 10 gateways.
- Oceanside, CA
    - Water metering solutions
- Otay Water District CA
- Pinellas County, FL
    - Water metering solutions

- Pittsburgh, PA
    - Smart airport operations at Pittsburgh International Airport, including asset tracking, environmental monitoring, and improving operational efficiency.
    - Over 2,000 LoRaWAN devices at the airport, supported by 30+ gateways.
- Riverside, CA
    - Water metering solutions
- Rockdale, County, GA
    - Water metering solutions
- Rockwood PUD
    - 13,860 sensors
- San Diego, CA
    - Smart water metering, energy management for buildings, and public safety initiatives.
    - Approximately 6,000 smart water meters and environmental sensors, supported by 50+ gateways.
- San Francisco, CA
    - Smart water metering, waste management, environmental monitoring, and public safety (emergency response systems).
    - Around 5,000 smart water meters and 500+ environmental sensors, with approximately 40 gateways.
- Tamarac FL
    - 20,888 sensors
- Tampa, FL
    - Public LoRaWAN network supporting a variety of IoT applications for municipal services, including waste management and environmental monitoring.
    - Over 2,500 LoRaWAN devices for various applications, supported by 40+ gateways.
- Town of Cary, NC
    - Environmental monitoring, water management, and public safety through smart sensors deployed across the town.
    - 3,000+ devices for environmental and water monitoring, supported by 30 gateways.
- Yorktown, TX
    - Smart agriculture, including livestock tracking and water management systems.
    - 1,200 livestock tracking and water management sensors, supported by 15 gateways.
    - Started 175 Accounts, 1,000+ remaining
- California (CALFIRE)
    - Piloting wildfire sensors for early detection and response.
- U.S. Army
    - Advanced communication systems for public safety operations using LoRaWAN
- DIMO
    - Consumer vehicle tracking and telematics.
- University of Florida Biology
    - Carbon flux studies.

- Texas A&M
    - Guardian dog program for animal tracking.
- USGS
    - Environmental monitoring.
- PG&E
    - Weather data collection.
- NMSU
    - Cattle tracking solutions.
- MarineSync
    - Deployment of approximately 10,000 water meters.
- Bearcom
    - Deployment for staff safety.
- VisionMetering
    - Over 400,000 LoRa devices deployed in the U.S.

ANNEX 2

Technical Analysis

As the Commission noted in the Public Notice, “coexistence between services require M-LMS licensees to demonstrate through field tests that their systems do not cause unacceptable levels if interferences to Part 15 devices.”

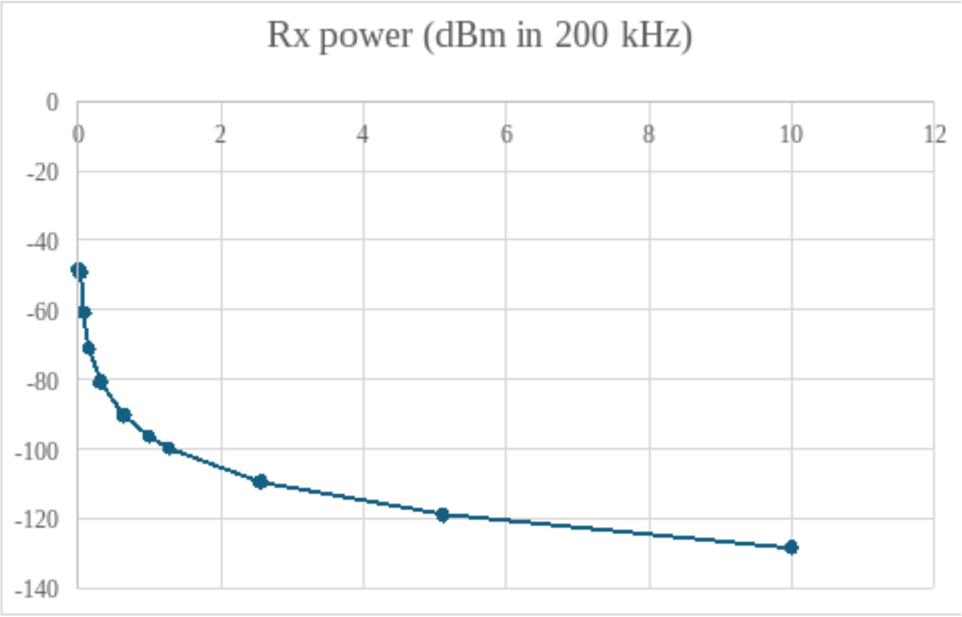
However, NextNav's proposal, which essentially seeks to repurpose this spectrum for 5G broadband licensed use, poses significant additional risks for all spectrum users that have deployed IoT essential services. Based on technical information in the NextNav Supplement, the Alliance calculates that each new NextNav gateway, operating under the proposed conditions, would be expected to cause harmful interference with LoRaWAN devices within a 5 km radius in urban areas, disrupting essential services in thousands of cities in U.S. This impact could be even more pronounced in rural areas due to the unique propagation characteristics of these environments.

In the Appendix to its petition for rulemaking, NextNav indicates that the Base Stations must not exceed an ERP of 1000 W/MHz. LoRaWAN devices are operated with a receiver bandwidth of 200 kHz and 0 dBi antenna gain, at 1.5 m (2). The following equation provides the amount of power received by a LoRaWAN device:

- Pr(dBm)=10 x log10 (1000/5) + 2.15 + 30dB – Att = 55.15 dBm – Att (dB)
- Att is the attenuation in dB resulting from the environment.

The LoRaWAN devices can typically accept an interference level about -120 dBm (2). It means that the attenuation should be about 175 dB between the Base Station and the LoRaWAN devices to make sure that the devices will not be interfered.

- Using the free space model (3), about 15,000 km would be necessary.
- Considering a model such as the Extended Okamura Hata model in urban environment (4), the separation would be around 5 kilometers.



As such, the Base Stations of NextNav network are then not compatible with the deployment of LoRaWAN networks.

It should be noted that the above calculations considered an ERP of 1000 W/MHz, however, NextNav requests that rural Base Stations can be operated up to 2000 W/MHz (see Table 2 in (1) making the interference situation even worse.

- (1) Rules supplement to NextNav Inc. petition for rulemaking, ECFS INBOX-1.401
- (2) ETSI TR 103 526 V1.1.1 (2018-04): System Reference document (SRdoc); Technical characteristics for Low Power Wide Area Networks Chirp Spread Spectrum (LPWAN-CSS) operating in the UHF spectrum below 1 GHz

- (3) Recommendation ITU-R P.525: Calculation of free-space attenuation
- (4) Report ITU-R SM.2028-2: Monte Carlo simulation methodology for the use in sharing and compatibility studies between different radio services or systems